MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

PGC0225 – GENERAL CHEMISTRY

(Foundation in Life Sciences students only)

25 October 2019
9.00 a.m – 11.00 a.m

(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **5** pages with **5** questions only.
2. Answer **ALL** questions.
3. Please write all your answers in the answer booklet provided.
4. Distribution of marks for each question is given.
5. Calculator is permitted.

Instructions: Answer **ALL** questions.

Question 1 [10 marks]

a. Cisplatin, an anticancer agent used for the treatment of solid tumors, is prepared by the reaction of ammonia with potassium tetrachloroplatinate:

$$K_2PtCl_4 + 2\,NH_3 \rightarrow Pt(NH_3)_2Cl_2 + 2\,KCl$$

Potassium tetrachloroplatinate — Cisplatin

Assume that 10.0 g of K_2PtCl_4, and 10.0 g of NH_3 are allowed to react.
[Molar mass of: K_2PtCl_4 = 415.3 g/mol; NH_3 = 17 g/mol; $Pt(NH_3)_2Cl_2$ = 300.1 g/mol]

(i) Which reactant is limiting, and which is in excess? [2 marks]
(ii) How many grams of the excess reactant are consumed, and how many grams remain? [1 mark]
(iii) How many grams of cisplatin are formed? [1 mark]

b. Stomach acid, a dilute solution of HCl in water, can be neutralized by reaction with sodium hydrogen carbonate, $NaHCO_3$.

(i) Write the balanced equation for the chemical reaction mentioned above. [1 mark]
(ii) How many milliliters of 0.125 M $NaHCO_3$ solution are needed to neutralize 18.0 mL of 0.100 M HCl? [1 mark]

c. Write unbalanced half-reactions (indicate the change of oxidation number) for the following net ionic equation: [2 marks]

$$Mn^{2+}(aq) + ClO_3^-(aq) \rightarrow MnO_2(s) + ClO_2(aq)$$

d. How much heat (in kilojoules) is evolved when 5.00 g of aluminum reacts with a stoichiometric amount of Fe_2O_3? [2 marks]
[Atomic mass: Al = 27.0]

$$2\,Al(s) + Fe_2O_3(s) \rightarrow 2\,Fe(s) + Al_2O_3(s) \qquad \Delta H^\circ = -852\ kJ$$

Continued.....

Question 2 [10 marks]

a. What is the energy (in kilojoules per mole) of photons of radar waves with $\nu = 3.35 \times 10^8$ Hz? [Planck's constant, $h = 6.626 \times 10^{-34}$ J·s] [2 marks]

b. State which of the following combinations of quantum numbers are not allowed. Explain your answer.

(i) $n = 3, l = 0, m_l = -1$ [2 × ½ mark]
(ii) $n = 4, l = 4, m_l = 0$ [2 × ½ mark]

c. According to the aufbau principle, which orbital is filled immediately after each of the following in a multi-electron atom?

(i) 4*s* [½ mark]
(ii) 3*d* [½ mark]

d. Like the other halogens, astatine is a nonmetal. It is located in Group VII, after iodine. However, little is known about the chemistry of astatine (At) from direct observation, but reasonable predictions can be made.

(i) Is astatine likely to be a gas, liquid, or a solid? [½ mark]
(ii) What colour is astatine likely to have? [½ mark]
(iii) Is astatine likely to react with sodium? If so, what is the formula of the product? [2 × ½ mark]

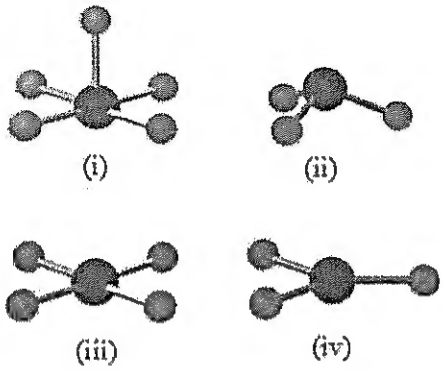
e. Write a balanced equation for the reaction of lithium with each of the following substances.

(i) H_2 [1 mark]
(ii) H_2O [1 mark]
(iii) O_2 [1 mark]

Continued.....

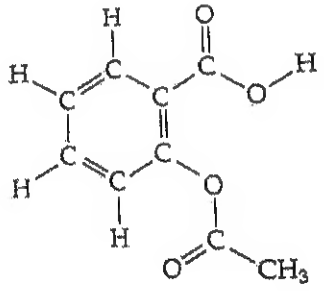
Question 3 [10 marks]

a. What is the geometry around the central atom in each of the following molecular models? [4 × ½ mark]



b. Draw the Lewis structure of bromine pentafluoride. [1 mark]

c. Aspirin has the following structure. Indicate the number of σ bonds and π bonds in the molecule, and state the hybridization of each carbon atom. [2 marks]



d. Identify the likely kinds of intermolecular forces in the following substances:

(i) HCl [1 mark]
(ii) CH_3CH_3 [1 mark]
(iii) CH_3NH_2 [1 mark]

e. Substance X has a vapor pressure of 100 mm Hg at its triple point (48°C), a melting point of 50°C and a boiling point of 100°C at 760 mm Hg. Sketch the phase diagram for X, including labels for the different phases, the triple point, the melting point, and the boiling point.

[2 marks]

Continued.....

Question 4 [10 marks]

a. The iodide ion reacts with hypochlorite ion in the following way:

$$OCl^- + I^- \rightarrow OI^- + Cl^-$$

This rapid reaction gives the following data:

Experiment	$[OCl^-]$ (M)	$[I^-]$ (M)	Initial Rate (M/s)
1	1.5×10^{-3}	1.5×10^{-3}	1.36×10^{-4}
2	3.0×10^{-3}	1.5×10^{-3}	2.72×10^{-4}
3	1.5×10^{-3}	3.0×10^{-3}	2.72×10^{-4}

(i) Determine the rate law for this reaction. [3 marks]
(ii) Calculate the rate constant. [1 mark]
(iii) Calculate the rate when $[OCl^-] = 2.0 \times 10^{-3}$ M and $[I^-] = 5.0 \times 10^{-4}$ M. [1 mark]

b. Sucrose, $C_{12}H_{22}O_{11}$, reacts slowly with water in the presence of an acid to form two other sugars, glucose and fructose.

$$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6\,(\text{glucose}) + C_6H_{12}O_6\,(\text{fructose})$$

The reaction is first order and has a rate constant of 6.2×10^{-5} s^{-1}. Suppose that the initial concentration of sucrose in the solution is 0.40 M.

(i) What will the sucrose concentration be after 2 hours? [1½ marks]
(ii) How many minutes will it take for the sucrose concentration to drop to 0.30 M? [1½ marks]

c. The equilibrium constant K_p for the decomposition of phosphorus pentachloride to phosphorus trichloride and molecular chlorine is found to be 1.05 at 250 °C. The reaction is shown below.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

(i) If the equilibrium partial pressures of PCl_5 and PCl_3 are 0.875 atm and 0.463 atm, respectively, what is the equilibrium pressure of Cl_2 at 250 °C? [1½ marks]
(ii) Write the expression for Kc for the above reaction. [½ mark]

Continued.....

Question 5 [10 marks]

a. Nitric acid (HNO_3) is used in the production of fertilizer, dyes and drugs. Calculate the pH of a HNO_3 solution having a hydrogen ion concentration of 0.76 *M*. [1½ marks]

b. What is the conjugate base of

(i) $HClO_4$ [½ mark]
(ii) PH_4^+ [½ mark]

c. A student prepared a 0.10 *M* solution of formic acid (HCOOH) and found its pH at 25°C to be 2.38.

(i) Write the ionization equation of formic acid forming H^+ ions. [½ mark]
(ii) Calculate K_a for formic acid at this temperature. [4 marks]

d. A sample of freshly pressed apple juice has a pOH of 10.24. Calculate the concentration of H^+. [2 marks]

e. Calculate the concentration of H^+ in a solution in which the concentration of OH^- is 0.001 *M*. [1 mark]

End of Paper